Temporal Heterogeneity, Zooplankton Composition and Fish Food supply in the Albufera of Minorca, a highly fluctuant environment

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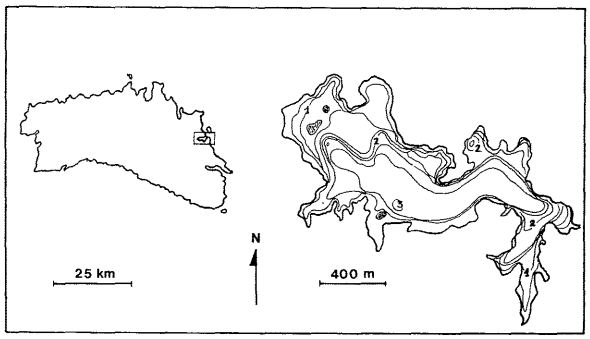
The Albufera of Minorca coastal lagoon is located in the NE cost of the island (fig.1), and its hydrological cycle depends upon a small basin ca. 25 Km^2. Some morphometrical parameters relevant to the following discussion are summarized in table 1. A tentative scheme of the long term changes in salinity of surface waters is presented in table 2.

Fig.1 Situation of the Albufera of Minorca and bathimetric map



For the 1983-84 period and to the descriptive purposes of this paper, a summary of its biophysical variation is derived following the results of a PCA of the main conservative (depth of the tube, temperature, evaporation, rainfall, mean monthly wind, alkalinity, SO_4, Cl, Ca, Mg, Na, K) and biologically dependent parameters (Secchi depth, surface and bottom oxygen content, pH, NO^3, NO_2, Fe, PO_4). Indeed, additional ecological information is achieved in the PCA because the Secchi depth (D) and PO_4 (P) contents of surface water showed strong correlation with Chlorophyll of water column ($D = 6.44\ Chl^{-0.325}$ $r = -0.998$ $p < 0.01$; $Chl = 17.71\ P^{1.135}$ $r = 0.983$ $p < 0.01$). As a result, two main factors contribute largely to the overall ecological variability: trophic level and salinity. The evolution of the lagoon, based in the position of the loading scores on the plane of these two factors, allows a typification of at least three situations. Always mesopolyhaline salinities are concerned: the high relative depth of the lagoon minimizes the interference and mixing between fall-winter freshwater inputs with "old" summer-fall polyhaline waters, making the occurrence of oligohaline states rather improbable (Pretus, 1989).

The three states are commented in the following lines:

Case 1. A winter-spring water, with salinities covering a range of 10 - 25 g/l. Microphytoplankton density increases until 10^6 cells/ml (*Nannochloris* sp.), this high density prevents, because of high turbidity, the development of macrophytes.

Case 2. A winter-spring water of similar salinity than in case 1, but with clean oligotrophic water column, controlled by a dense covering of *Chaetomorpha*, or a combination of this species with *Gracillaria*, adding *Rupia cirrhosa* in spring.

Case 3. Polyhaline summer-fall water, easily reaching 30°C in August. Seawater intrusions are frequent in this period, but usually mixed by the wind. Then the mean salinity of the lagoon remains between 22 - 30 g/l. This situation develops a mature covering of Rupia with peaks of phytoplankton (*Chaetoceros* sspp.), and clean waters with *Prorocentrum scutellum*.

Tab. 1. Morphometric parameters.

Surface	72.4 Ha
Maximum length	1700 m
Maximum depth	3 m
Mean depth	1.37 m
Relative depth	0.312 %

Tab. 2. Salinity (g/l) ranges and month measured

	Minimum	Maximum
1983	12.9 (III)	29.1 (XI)
1984	14.6 (IV)	>28.5 (VIII)
1987	3.7 (II)	29.4 (XI)
1988	11.6 (III)	27 (XI)
1989	23.0 (II)	33.2 (XII)

15 rotifera species were found, 5 of them were new records for the Balearic archipelago: *Notholca bipalium* (Müll.), *Proales reinhardti* (Ehrb.), *Synchaeta kitina* Rousselet, *Encentrum marinum* Dujardin and *Hexarthra oxyuris* (Sernov). *Brachionus plicatilis* Müll. was the most abundant species, and the only rotifer found in hipereutrophic states, with densities up to 2500 ind/l. Rotifer populations decreased and were controlled because of salinity, which affects fecundity rates more than other factors (Miracle & Serra, 1989). Relatively diverse rotifer communities occurred in winter-spring waters.

Crustacea species found were: *Acartia latisetosa* Kritsch., *Halicyclops neglectus* Kief., *Ectinosoma* sp., *Euterpina* sp. *Ergasillus sieboldii* Nordm., *Nitocra lacustris* (Schmank.), *Mesochra heldtii* Monard, *Tisbe longicornis* T. & A. Scott, *Cyprideis torosa* (Brady), *Cypridopsis* sp., *Mesopodopsis slabberi* (van Beneden), *Corophium insidiosum* Crawford, *Gammarus aequicauda* Martynov, *Lekanesphaera hookeri* (Leach), *Palaemon serratus* (Pennant), and *Carcinus aestuarii* Czerniavsky. *Acartia latisetosa* behaves as a true planktonic species, and its densities increased in the hipereutrophic state of the lagoon. The harpacticoidea were found mainly close to the bottom algal and macrophytic communities, and occurred from June onward in the summer. Several species disappeared during the hipereutrophic period and reappeared later:*Masopodopsis slabberi, Cyprideis torosa* and *Corophium insidiosum*.

Five grey mullets were found in the lagoon: *Mugil cephalus* (L.), *Chelon labrosus* (Risso), *Liza (Liza) ramada* (Risso), *Liza (Liza) aurata* (Risso), and *Liza (Protomugil) saliens* (Risso). Gut contents analysis revealed an occasional intake of small organisms as *Brachionus* and some harpacticoidea, whilst ostracoda, *Gammarus*, and *Corophium* are more common preys. That pattern shows a high selectivity of food supply by grey mullets.

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Rehabilitation of Open Waters within the Albufera of Majorca (selective criteria)

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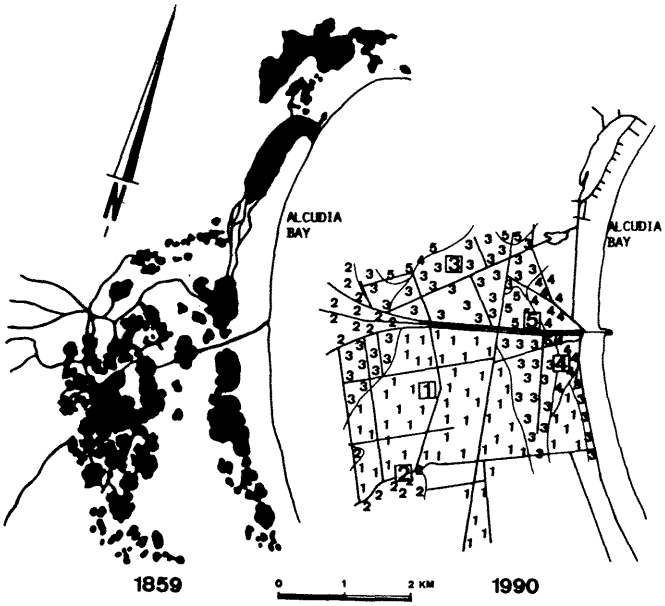
In 1988 a Natural Park was declared in part of the Albufera region. At present only 3% of the surface area is open water whereas last century water covered 30-40%. In consequence the food resources and habitat of aquatic species have been greatly reduced and the landscape is very homogeneous with emergent macrophytes.

In order to rehabilitate the area we propose an increase in the volume of water which will thus have a longer residence time within the Park.



A plan for use and management (MAYOL 1989) and limnological criteria for the rehabilitation of the Park (MARTINEZ-TABERNER et al. 1990) have been published. The present work discusses one of the criteria in the latter.

By predicting the distribution of submerged macrophytes we can determine the aquatic zones suitable for rehabilitation. We hope to guarantee the continuing existence of aquatic communities that are present but poorly represented and to rehabilitate areas for the reintroduction of those species which have disappeared (BARCELO-COMBIS, 1879-81; MARTINEZ-TABERNER, 1986; MARTINEZ-TABERNER & PERICAS, 1988).

From the existing information on the physico-chemical dynamics of the water and from the environmental tolerances of species we can predict the most likely species in the zones of the Albufera which were previously open waters (see map of 1859). Having established this prediction we can determine the criteria for the selection of new environments within the Natural Park in the following way:

a.- On the vegetation map of the Albufera (FORTEZA & MARTINEZ-TABERNER, 1987), ponds for each community of emergent macrophytes will be included (see map 1990) i.e. a ponds within *Soncho-Cladietum marisci* (1), *Typho Schoenoplectetum glauci* (2), *Scirpietum maritimi-litoralis* (3), *Juncion maritimi* (4) and *Artrocnemetum fruticosi* (5).

b.- The potential vegetation map is superimposed on the map with the planned ponds (see map of 1990 with squares) and we will eliminate those that offer the same potential vegetation and those that already exist.

Thus we will obtain not only food resources and new habitats but these resources will also be sufficiently diverse to ensure the existence of many different species. It could be thought that it would be better to invest in a single lagoon but this would only provide a homogeneous change within the Albufera and would only serve to maintain many individuals of very few species. Furthermore this would homogenize the present physico-chemical gradient of the waters which is the most important characteristic of the Park, since it allows a wide diversity of environments and species within a small area.

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